

## N-channel 900 V, 0.088 $\Omega$ typ., 40 A MDmesh™ K5 Power MOSFETs in TO-247 and TO-247 long leads packages

Datasheet - production data

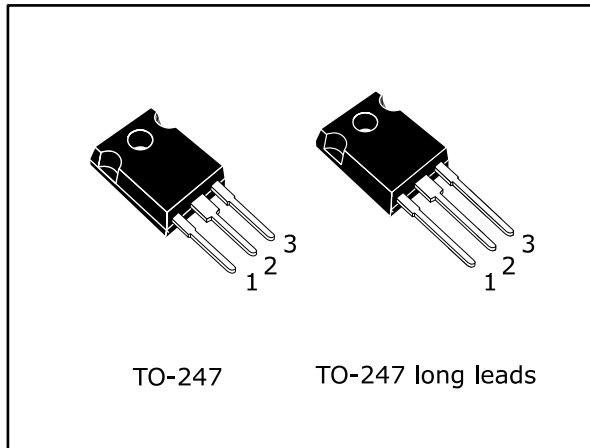


Figure 1: Internal schematic diagram

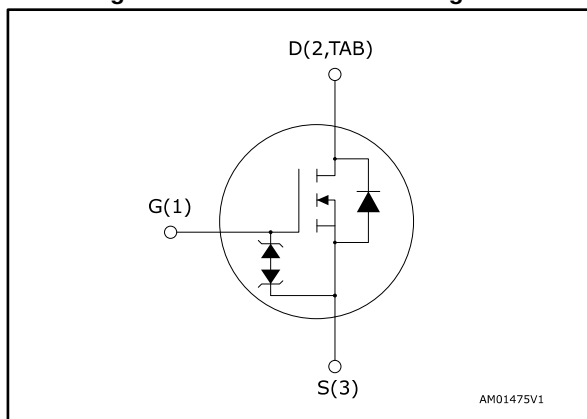


Table 1: Device summary

Order code	Marking	Package	Packaging
STW40N90K5	40N90K5	TO-247	Tube
STWA40N90K5		TO-247 long leads	

### Features

Order code	V <sub>DS</sub>	R <sub>DS(on)</sub> max	I <sub>D</sub>
STW40N90K5	900 V	0.099 $\Omega$	40 A
STWA40N90K5			

- Industry's lowest R<sub>DS(on)</sub> x area
- Industry's best FoM (figure of merit)
- Ultra-low gate charge
- 100% avalanche tested
- Zener-protected

### Applications

- Switching applications

### Description

These very high voltage N-channel Power MOSFETs are designed using MDmesh™ K5 technology based on an innovative proprietary vertical structure. The result is a dramatic reduction in on-resistance and ultra-low gate charge for applications requiring superior power density and high efficiency.

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# 1 Electrical ratings

**Table 2: Absolute maximum ratings**

Symbol	Parameter	Value	Unit
$V_{GS}$	Gate- source voltage	$\pm 30$	V
$I_D$	Drain current (continuous) at $T_C = 25\text{ }^\circ\text{C}$	40	A
$I_D$	Drain current (continuous) at $T_C = 100\text{ }^\circ\text{C}$	25	A
$I_D^{(1)}$	Drain current (pulsed)	160	A
$P_{TOT}$	Total dissipation at $T_C = 25\text{ }^\circ\text{C}$	446	W
$dv/dt^{(2)}$	Peak diode recovery voltage slope	4.5	V/ns
$dv/dt^{(3)}$	MOSFET $dv/dt$ ruggedness	50	V/ns
$T_j$	Operating junction temperature range	-55 to 150	$^\circ\text{C}$
$T_{stg}$	Storage temperature range		

**Notes:**

(1)Pulse width limited by safe operating area

(2) $I_{SD} \leq 40\text{ A}$ ,  $di/dt \leq 100\text{ A}/\mu\text{s}$ ,  $V_{DS(\text{peak})} \leq V_{(BR)DSS}$ ,  $V_{DD}=450\text{ V}$

(3) $V_{DS} \leq 720\text{ V}$

**Table 3: Thermal data**

Symbol	Parameter	Value	Unit
$R_{thj\text{-case}}$	Thermal resistance junction-case max	0.28	$^\circ\text{C}/\text{W}$
$R_{thj\text{-amb}}$	Thermal resistance junction-amb	50	$^\circ\text{C}/\text{W}$

**Table 4: Avalanche characteristics**

Symbol	Parameter	Value	Unit
$I_{AR}$	Avalanche current, repetitive or not repetitive (pulse width limited by $T_{j\text{max}}$ )	13.5	A
$E_{AS}$	Single pulse avalanche energy (starting $T_J = 25\text{ }^\circ\text{C}$ , $I_D = I_{AR}$ , $V_{DD} = 50\text{ V}$ )	750	mJ

## 2 Electrical characteristics

( $T_{\text{case}} = 25\text{ °C}$  unless otherwise specified)

**Table 5: On /off states**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_{(BR)DSS}$	Drain-source breakdown voltage	$V_{GS} = 0\text{ V}$ , $I_D = 1\text{ mA}$	900			V
$I_{DSS}$	Zero gate voltage drain current	$V_{GS} = 0\text{ V}$ , $V_{DS} = 900\text{ V}$			1	$\mu\text{A}$
		$V_{GS} = 0\text{ V}$ , $V_{DS} = 900\text{ V}$ , $T_C = 125\text{ °C}^{(1)}$			50	$\mu\text{A}$
$I_{GSS}$	Gate-body leakage current	$V_{DS} = 0\text{ V}$ , $V_{GS} = \pm 20\text{ V}$			$\pm 10$	$\mu\text{A}$
$V_{GS(th)}$	Gate threshold voltage	$V_{DS} = V_{GS}$ , $I_D = 100\text{ }\mu\text{A}$	3	4	5	V
$R_{DS(on)}$	Static drain-source on-resistance	$V_{GS} = 10\text{ V}$ , $I_D = 20\text{ A}$		0.088	0.099	$\Omega$

**Notes:**

<sup>(1)</sup>Defined by design, not subject to production test.

**Table 6: Dynamic**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$C_{iss}$	Input capacitance	$V_{GS} = 0\text{ V}$ , $V_{DS} = 100\text{ V}$ , $f = 1\text{ MHz}$	-	3263	-	pF
$C_{oss}$	Output capacitance		-	212	-	pF
$C_{rss}$	Reverse transfer capacitance		-	1.3	-	pF
$C_{o(tr)}^{(1)}$	Equivalent capacitance time related	$V_{GS} = 0\text{ V}$ , $V_{DS} = 0\text{ V to } 720\text{ V}$	-	429	-	pF
$C_{o(er)}^{(2)}$	Equivalent capacitance energy related		-	159	-	pF
$R_G$	Intrinsic gate resistance	$f = 1\text{ MHz}$ , $I_D = 0\text{ A}$	-	1.9	-	$\Omega$
$Q_g$	Total gate charge	$V_{DD} = 720\text{ V}$ , $I_D = 40\text{ A}$	-	89	-	nC
$Q_{gs}$	Gate-source charge	$V_{GS} = 10\text{ V}$	-	25	-	nC
$Q_{gd}$	Gate-drain charge	(see <a href="#">Figure 15: "Test circuit for gate charge behavior"</a> )	-	37.5	-	nC

**Notes:**

<sup>(1)</sup>Time related is defined as a constant equivalent capacitance giving the same charging time as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

<sup>(2)</sup>energy related is defined as a constant equivalent capacitance giving the same stored energy as  $C_{oss}$  when  $V_{DS}$  increases from 0 to 80%  $V_{DSS}$

Table 7: Switching times

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$t_{d(on)}$	Turn-on delay time	$V_{DD} = 450 \text{ V}$ , $I_D = 40 \text{ A}$ , $R_G = 4.7 \text{ } \Omega$ , $V_{GS} = 10 \text{ V}$ (see <a href="#">Figure 14: "Test circuit for resistive load switching times"</a> )	-	30.4	-	ns
$t_r$	Rise time		-	15.5	-	ns
$t_{d(off)}$	Turn-off-delay time		-	84.5	-	ns
$t_f$	Fall time		-	13.4	-	ns

Table 8: Source drain diode

Symbol	Parameter	Test conditions	Min.	Typ.	Max	Unit
$I_{SD}$	Source-drain current		-		40	A
$I_{SDM}^{(1)}$	Source-drain current (pulsed)		-		160	A
$V_{SD}^{(2)}$	Forward on voltage	$I_{SD} = 40 \text{ A}$ , $V_{GS} = 0 \text{ V}$	-		1.5	V
$t_{rr}$	Reverse recovery time	$I_{SD} = 40 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ (see <a href="#">Figure 17: "Unclamped inductive load test circuit"</a> )	-	693		ns
$Q_{rr}$	Reverse recovery charge		-	22		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	63		A
$t_{rr}$	Reverse recovery time	$I_{SD} = 40 \text{ A}$ , $di/dt = 100 \text{ A}/\mu\text{s}$ $V_{DD} = 60 \text{ V}$ , $T_J = 150 \text{ }^\circ\text{C}$ (see <a href="#">Figure 17: "Unclamped inductive load test circuit"</a> )	-	884		ns
$Q_{rr}$	Reverse recovery charge		-	29		$\mu\text{C}$
$I_{RRM}$	Reverse recovery current		-	65.5		A

**Notes:**

(1) Pulse width limited by safe operating area.

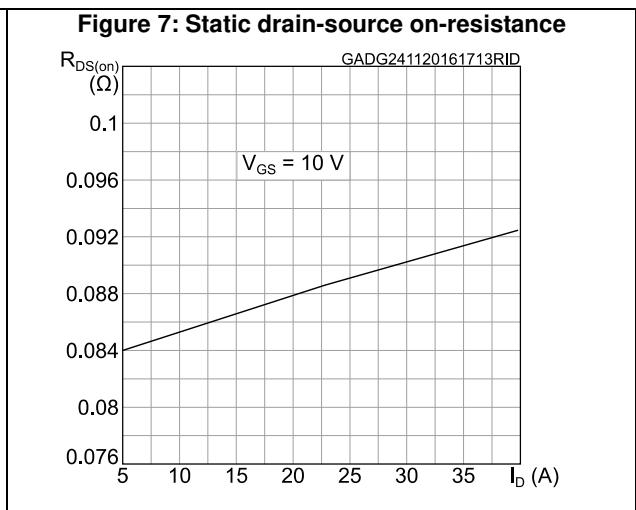
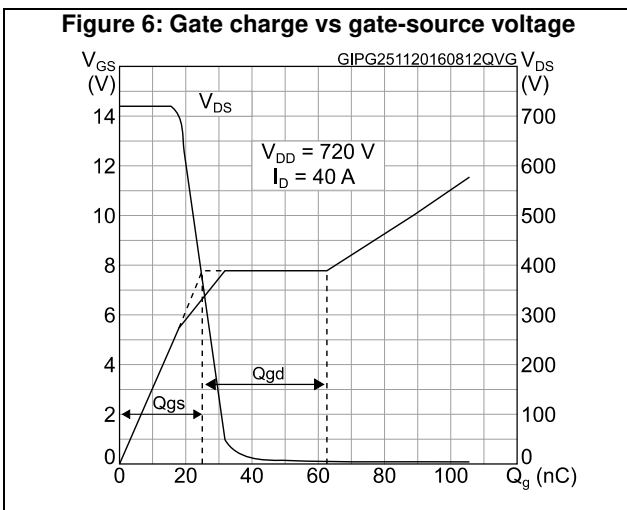
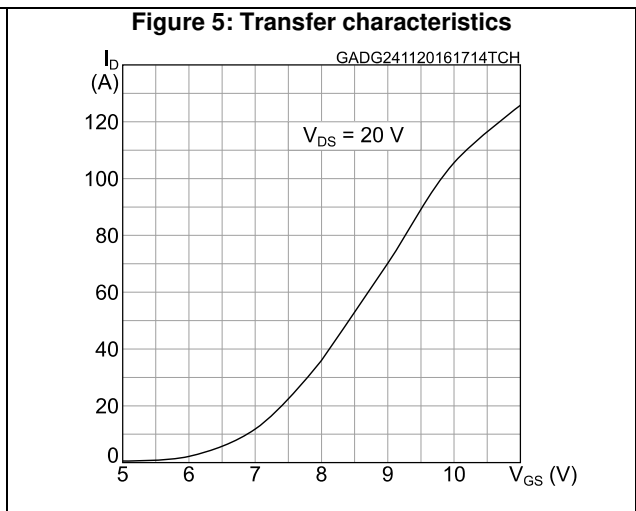
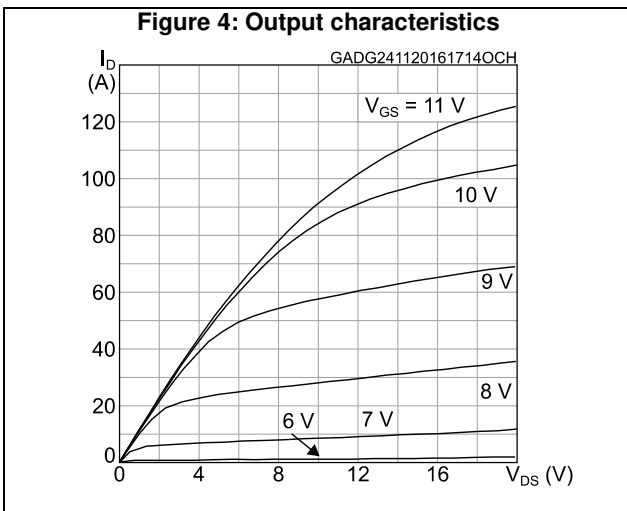
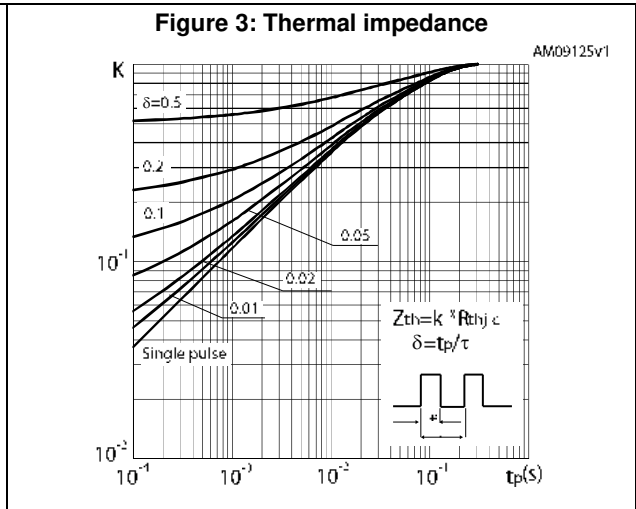
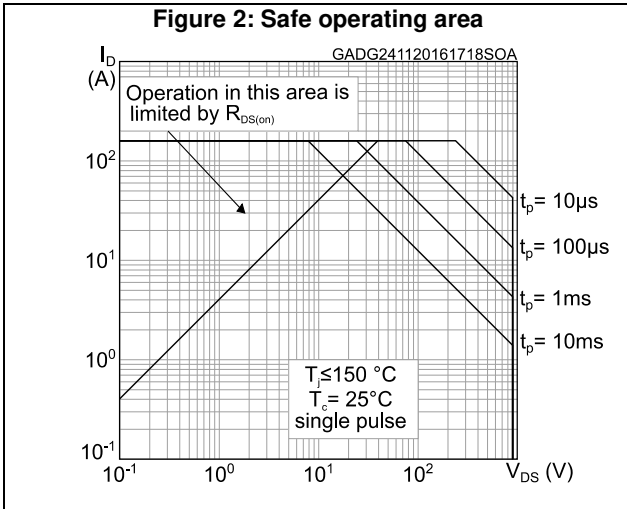
(2) Pulsed: pulse duration = 300  $\mu\text{s}$ , duty cycle 1.5%

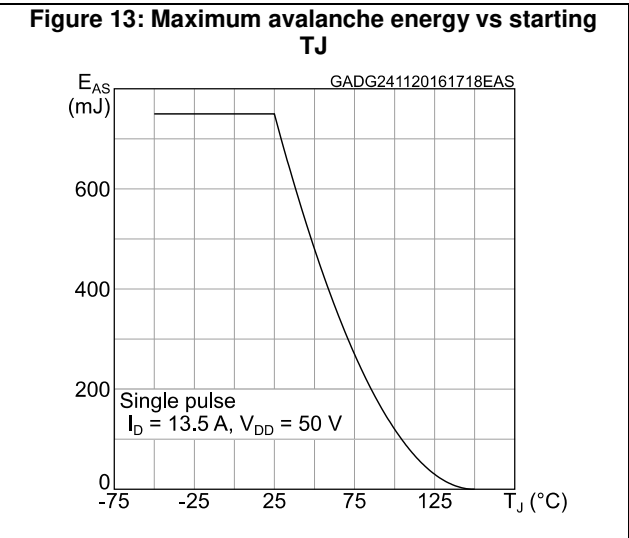
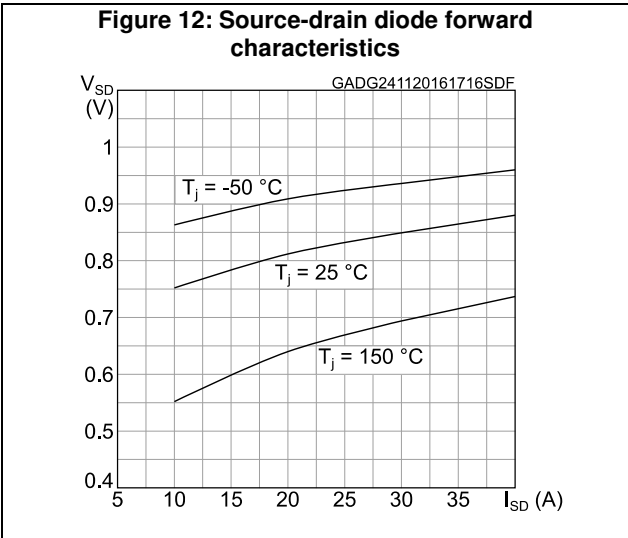
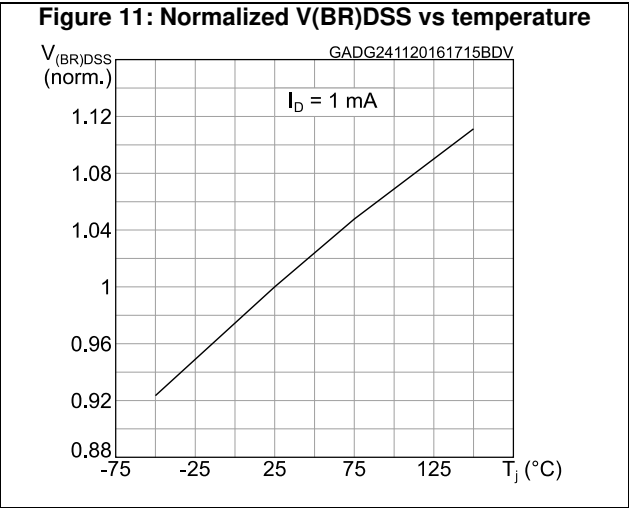
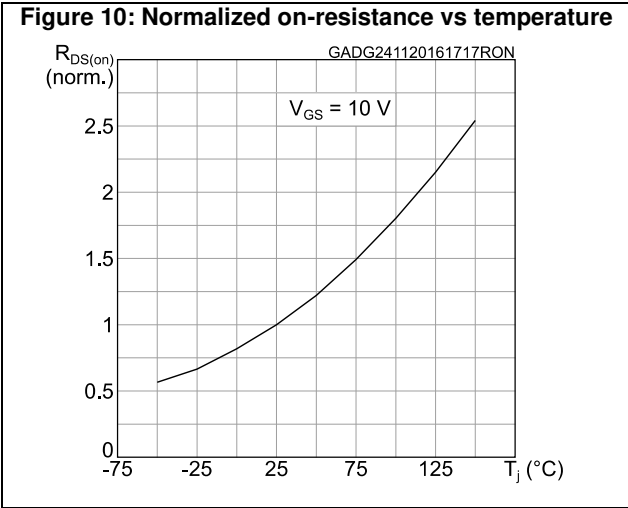
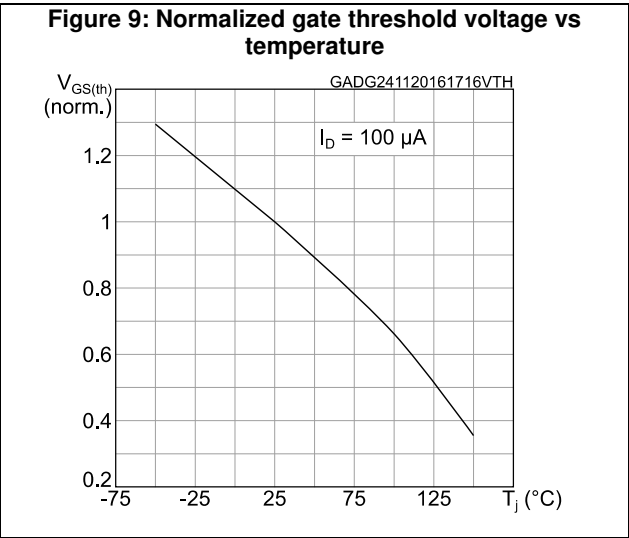
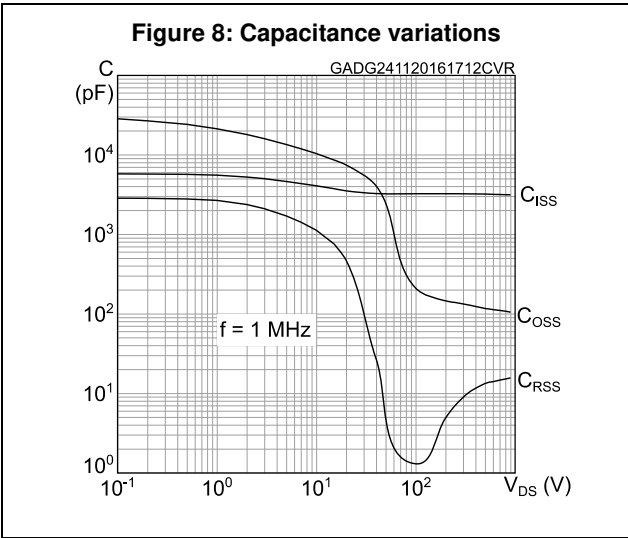
Table 9: Gate-source Zener diode

Symbol	Parameter	Test conditions	Min	Typ.	Max.	Unit
$V_{(BR)GSO}$	Gate-source breakdown voltage	$I_{GS} = \pm 1 \text{ mA}$ , $I_D = 0 \text{ A}$	30	-	-	V

The built-in back-to-back Zener diodes are specifically designed to enhance the ESD performance of the device. The Zener voltage facilitates efficient and cost-effective device integrity protection, thus eliminating the need for additional external componentry.

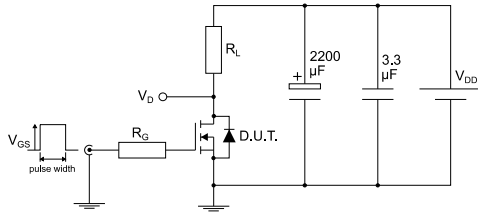
## 2.1 Electrical characteristics (curves)





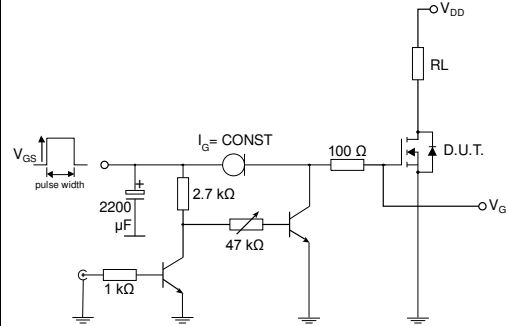
### 3 Test circuits

**Figure 14: Test circuit for resistive load switching times**



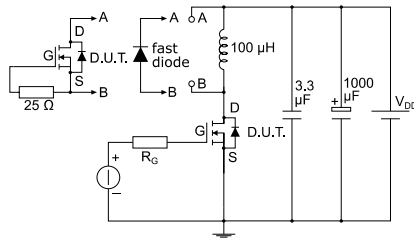
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**Figure 15: Test circuit for gate charge behavior**



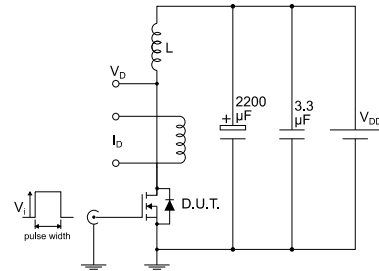
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**Figure 16: Test circuit for inductive load switching and diode recovery times**



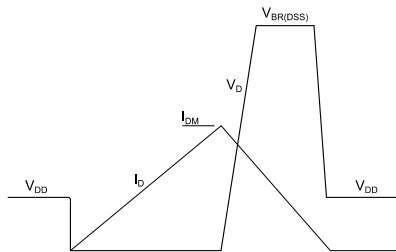
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**Figure 17: Unclamped inductive load test circuit**



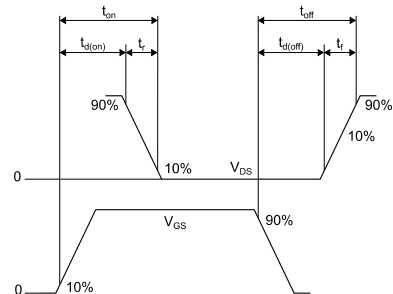
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**Figure 18: Unclamped inductive waveform**



AM01472v1

**Figure 19: Switching time waveform**



AM01473v1



## 4 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK® is an ST trademark.

### 4.1 TO-247 package information

Figure 20: TO-247 package outline

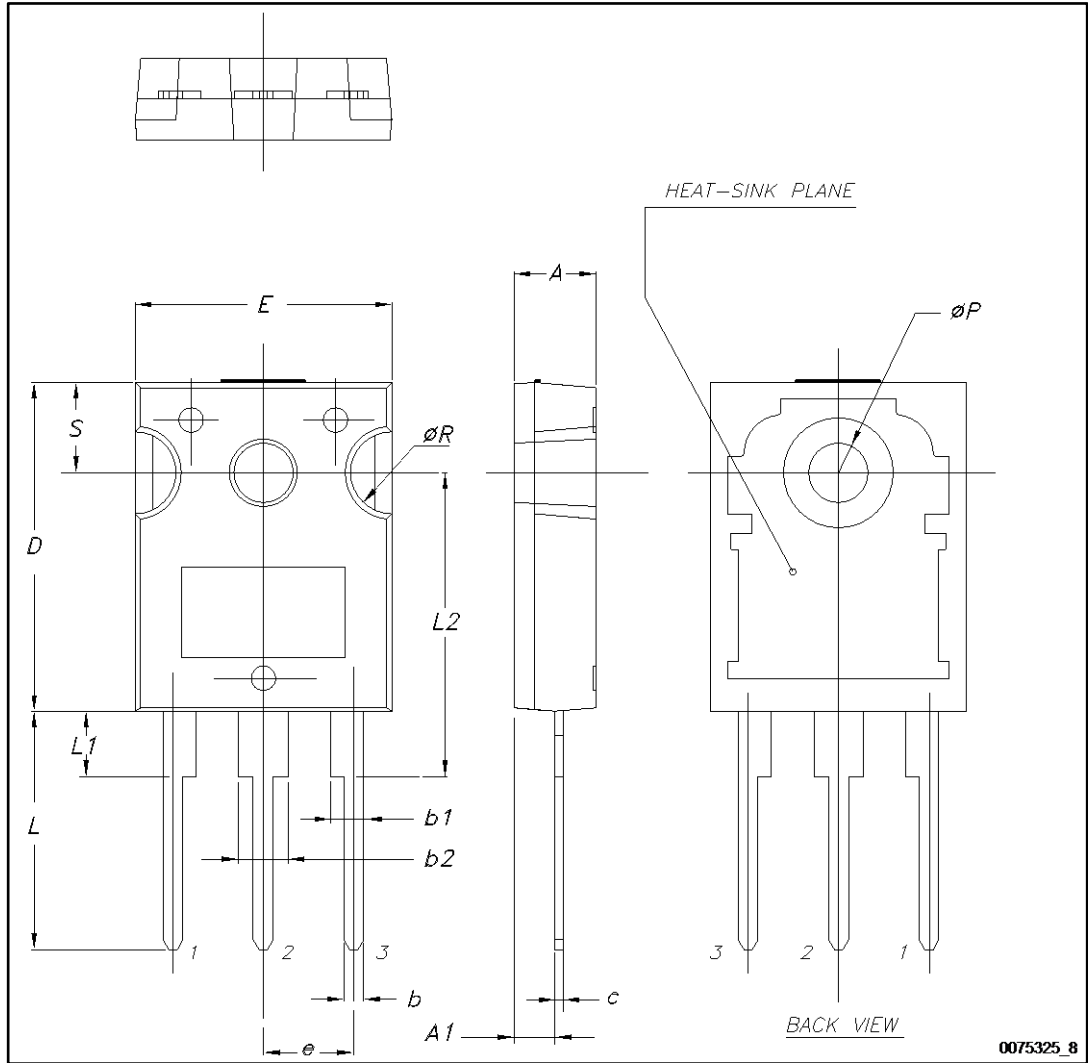


Table 10: TO-247 package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.85		5.15
A1	2.20		2.60
b	1.0		1.40
b1	2.0		2.40
b2	3.0		3.40
c	0.40		0.80
D	19.85		20.15
E	15.45		15.75
e	5.30	5.45	5.60
L	14.20		14.80
L1	3.70		4.30
L2		18.50	
ØP	3.55		3.65
ØR	4.50		5.50
S	5.30	5.50	5.70

### 4.2 TO-247 long leads package information

Figure 21: TO-247 long lead package outline

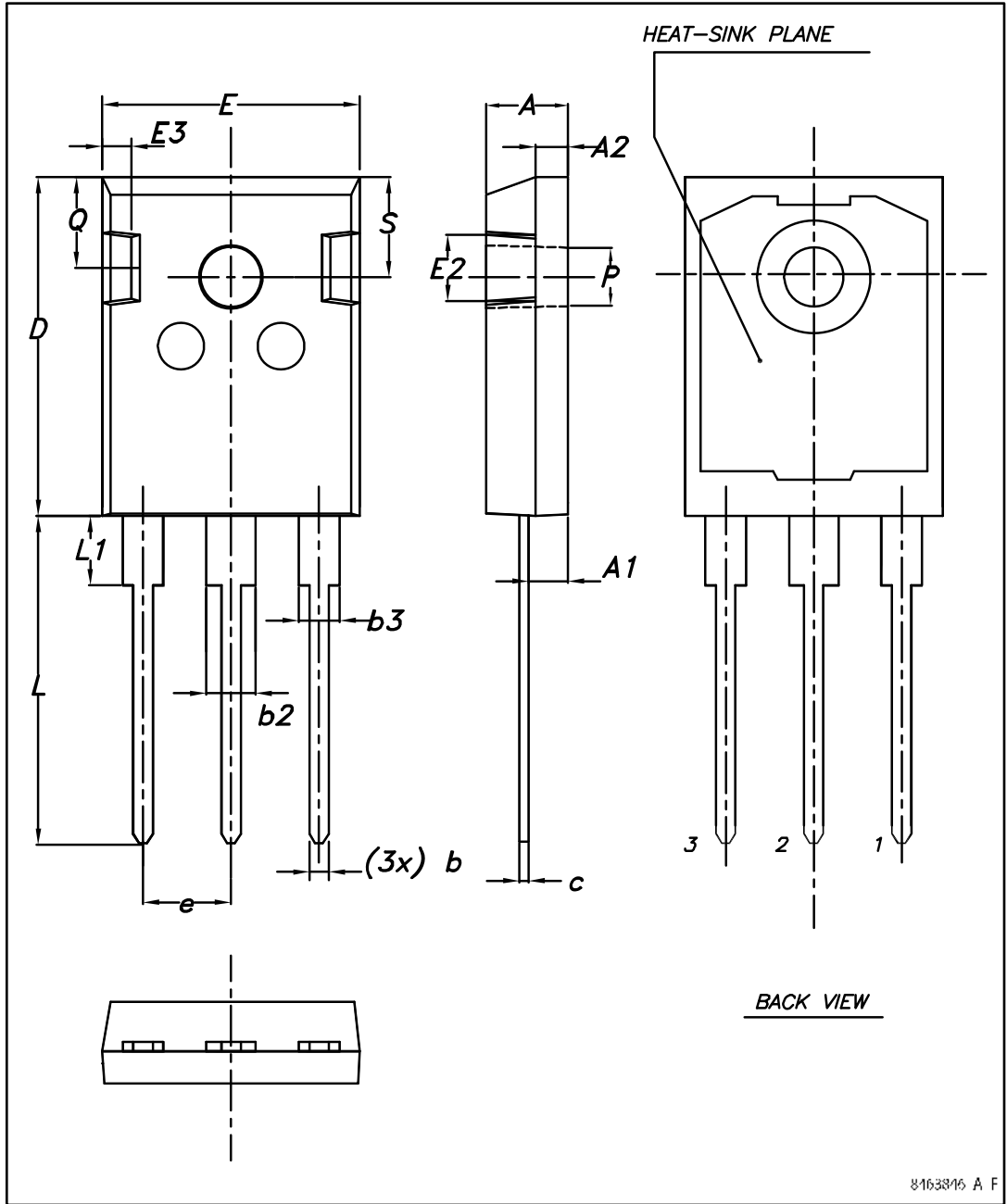


Table 11: TO-247 long lead package mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.90	5.00	5.10
A1	2.31	2.41	2.51
A2	1.90	2.00	2.10
b	1.16		1.26
b2			3.25
b3			2.25
c	0.59		0.66
D	20.90	21.00	21.10
E	15.70	15.80	15.90
E2	4.90	5.00	5.10
E3	2.40	2.50	2.60
e	5.34	5.44	5.54
L	19.80	19.92	20.10
L1			4.30
P	3.50	3.60	3.70
Q	5.60		6.00
S	6.05	6.15	6.25

## 5 Revision history

Table 12: Document revision history

Date	Revision	Changes
26-Jan-2016	1	First release.
25-Nov-2016	2	Updated <i>Section 1: "Electrical ratings"</i> and <i>Section 2: "Electrical characteristics"</i> Added <i>Section 2.1: "Electrical characteristics (curves)"</i> . Document status changed from preliminary to production data. Minor text changes.

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